Progress Report
June 2001

FHWA POOLED-FUND PROJECT NUMBER: ***TPF5-(003)***

TITLE: Extending the Season for Concrete Construction and Repair

PRINCIPAL INVESTIGATOR: Charles Korhonen, US Army Cold Regions Research and Engineering Laboratory, 72 Lyme Road, Hanover, NH 03755. Phone: 603/646-4438. Fax: 603/646-4640. E-mail: Charles.J.Korhonen@erdc.usace.army.mil

OBJECTIVE: To develop an antifreeze admixture conforming to existing industry standards. This work will adapt recently developed knowledge about off-the-shelf admixtures to the specific conditions of highway construction. The admixture will protect concrete to 23°F or lower and allow concrete to gain appreciable strength while at that temperature.

PROGRESS: 13 Apr 2001 through 01 June 2001

Problem with the SPR number: The problems with the FHWA project number have finally been resolved. While the project was scheduled to start 01 Oct '00, a couple of tries were needed to get the funding number to work properly. We received a disbursement of funds for the first year from NY, PA and WY through FHWA in April under project number **TPF-5(003)**. We do not have confirmation of additional funds going to FHWA as of this writing.

Web page: Based on popular demand, we have developed a web page that addresses a range of topics for cold-weather concrete: www.crrel.usace.army.mil/concrete. This page is still under construction so visit it again at a later date to see what else we have added. For a direct link to information for this pooled-fund project click on this url: <http://www.crrel.usace.army.mil/concrete/Antifreeze_Admixtures.htm> Once there, click on "Extending the season for concrete construction and repair" and this page will be your central location for fact sheets, FAQ, progress reports, briefings and etc. Check out the "Briefing", several states have already used it to their advantage.

Goals: The following is a shortened outline of this project extracted from the full proposal dated 13 June 2000. Our first goal is to define in the laboratory a preliminary combination of off-the-shelf admixtures that will not affect the workability or the durability of concrete and that will accelerate cement hydration and promote appreciable strength gain at below-freezing temperatures. The plan is to assure that the preliminary admixture formulations work under actual construction conditions in cold outdoor weather.

Optimization, proof of concept, and field demonstrations, hosted by a state DOT, are planned for the second year of the study. The final year of this project is dedicated to reporting and transferring this new cold-weather technology to the DOT partners along with tying up any loose ends from the previous two years

Accomplishments: The project number glitch has slowed our work since October 2000. In spite of this, we went ahead to secure a range of admixtures from WR Grace and Master Builders to be ready when the funds arrived. We also received information from many of the

participating states to settle in on the mix designs that we will use in this study. The information showed us that w/c ratios between 0.40 and 0.48 cover a majority of the mixes used by DOTs. Cement types vary quite widely and it would be impossible to study each type used by our partners. However, we feel we can get around that potential problem by developing thermal signatures of cements in the lab.

So far, using the thermal-signature approach, we have been able to determine how various admixtures affect the rate at which heat is generated in a given cement and this information has proved quite valuable in predicting expected field behavior of concrete.

We have tested many combinations of various admixtures from WR Grace in laboratory concrete. We took advantage of the last two weeks of cold weather in April to field test several of these lab mixes in a full-scale field-test at a local ready-mix plant. Though brief, this time in the field has given us valuable information to compare lab to field conditions, which will help us during this summer's lab portion.

At this point, we can confidently design a -5°C concrete using three WR Grace products plus one of their water reducers. Our main problem is that the concrete has a tendency to lose slump too rapidly. Our goal is to create an antifreeze concrete that has the same workability, as does a control concrete. In our two weeks of field trials, our first antifreeze concrete lost slump from 4" to 1.5" after 45 min in a truck and from 6.5" to 3" after 20 min when dosed with a second set of admixtures at the site. For comparison, our control concrete went from 4" to 2" slump while in a truck for 45 min. Water was needed to bring it back up to 4". Based on feedback we've received, we are shooting for a concrete mix that will retain at least 2" slump while in transit for 45 min and that can be brought back to being workable for at least 20 min by adding admixtures at the construction site. We have cut down on the slump loss by increasing the initial slump to 8" and by delaying one of the admixtures until the truck is at the site. Our last field mix was able to have 4" of slump for about 20 min at the construction site. We will work to improve this this summer.

Preliminary testing on a variety of admixtures shows no adverse affect on freeze-thaw durability.

Work is progressing on a field portable device for measuring the freezing point of the concrete in after it has comes out of the truck.

LOOKING AHEAD:

WIDOT has volunteered to demonstrate our antifreeze mix on one of their projects in Rhinelander, WI. Thanks to Peter Kemp for heading this effort. Our goal is to test a mix during the winter of 2002.

This summer, our goal is to complete Phase I lab studies on the development of freeze-resistant concrete that maintains its workability over time. This will include w/c ratios between 0.40 and 0.48 using WR Grace and Master Builders admixtures. In addition, setting times,

workability issues, freeze protection limits, maturity functions, and freeze-thaw considerations will all be initiated or well under way.

This fall, several small-scale field tests will be conducted to ready us for the demonstration in Wisconsin.